

## Utility of nerve conduction studies for diagnosis of injury to the medial branch of the superficial radial nerve



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### ABSTRACT

**Introduction:** The clinical utility of nerve conduction study (NCS) for the distal medial branch of the superficial radial nerve (SRN) has not yet been clarified. Therefore, we investigated the clinical utility of NCS in patients with suspected SRN injury and compared the results with those in healthy control subjects.

**Methods:** Bilateral NCS of the medial branch of the SRN was performed in two patients with suspected injury of the medial branch of the SRN, and in 20 healthy control subjects. A surface recording electrode was placed at the medial side of the metacarpophalangeal joint of the thumb. The SRN was then stimulated at a location 12 cm proximal from the recording electrode.

**Results:** The mean sensory nerve action potential in the two patients was significantly lower than that of the controls ( $6.75 \pm 0.92$  vs.  $23.8 \pm 8.2 \mu\text{V}$ ,  $P < 0.05$ ). The side-to-side differences in sensory nerve action potential in the two patients were significantly higher than in the controls ( $55 \pm 7.1$  vs.  $11 \pm 7.8\%$ ,  $P < 0.05$ ).

**Conclusions:** NCS may be useful for diagnosing injury of the medial branch of the SRN.

### 1. Introduction

The superficial radial nerve (SRN), a sensory nerve of the forearm, is vulnerable to accidental or iatrogenic injuries because of its superficial position and because its branches cross the surface of the distal radius [1–3]. The SRN bifurcates into its medial and lateral branches approximately 4.9 cm proximal to the radial styloid process (Fig. 1A) [2,3]. The medial branch provides sensory innervation to the skin of the dorsomedial side of the thumb and the radial side of the hand and fingers, while the lateral branch innervates the skin of the dorsolateral side of the thumb [2–4]. Nerve conduction study (NCS) results have been reported for the medial branch of the SRN from the wrist (anatomical snuff box) [3,5] and the proximal phalanx of the thumb [4]. However, the clinical utility of NCS for more peripheral lesions at the wrist has not yet been investigated, and the previous NCS investigation recorded from the proximal phalanx of the thumb was performed in healthy subjects [4]. Furthermore, anatomically, injury of the more distal portion of the wrist might not be detected via the previous method [5]. Therefore, to clarify the clinical utility of NCS for distal SRN injury, we report the results of NCS in two patients with injury to the medial branch of the SRN and in 20 healthy control subjects.

### 2. Materials and methods

#### 2.1. Patients

**Patient 1:** A 68-year-old female who presented with a 1-year history of paresthesia after a hand injury due to falling on the road. She had decreased pain and thermal sensation in the right dorsomedial side of the thumb and dorsolateral side of the index finger without muscle weakness (Fig. 1B). **Patient 2:** A 76-year-old male who presented with a 2-month history of paresthesia, tingling sensations, decreased pain and thermal sensation in a lesion that was almost identical to that of patient 1.

#### 2.2. Healthy control subjects

We recruited 20 control subjects (six males, 14 females; mean age  $48.2 \pm 19.2$  years, range 21–85 years) with no history of previous neuromuscular disease nor abnormalities on neurological examination. A total of 40 nerves were tested. The study protocol conformed to the ethical guidelines of the 1964 Declaration of Helsinki and its later amendments.

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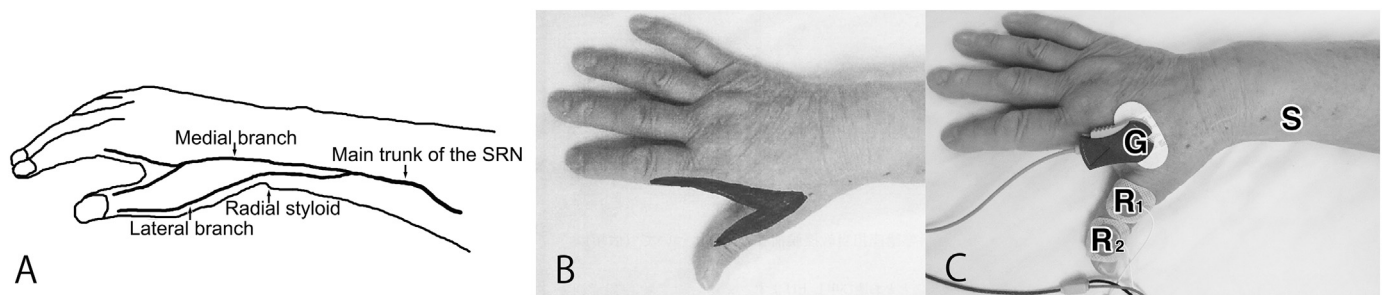
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**Fig. 1.** (A) Illustration of the superficial radial nerve and its branches. (B) Sensory disturbance lesion in patient 1. The painted area shows the region of hypoesthesia of pain and thermal sensation. (C) Positions of the electrodes in the nerve conduction study for the medial branch of the superficial radial nerve. G, ground electrode; R<sub>1</sub>, recording electrode; R<sub>2</sub>, reference electrode; S, stimulating electrode.

### 3. Methods

For NCS, we used an electromyography machine (Dantec Keypoint<sup>®</sup> software version 5.13; ALPINE BioMed, San Carlos, CA) with a standard sensory nerve conduction setting. In accordance with the previous study [4], NCS of the SRN were studied antidromically. In order to minimize the volume conduction, we placed a surface recording electrode on the skin just over the medial branch of the SRN at the dorsomedial aspect of the metacarpophalangeal joint of the thumb, and placed a reference electrode at the distal interphalangeal joint of the thumb within 2 cm distance from the recording electrode (Fig. 1C). An electrical stimulation was applied percutaneously at a location 12 cm proximal to the recording electrode, and a ground electrode was placed at the central dorsum of the hand (Fig. 1C). NCS of the SRN were performed on both hands of the subjects. The electrical stimulation was supramaximal and of 0.1 ms duration. We measured the onset latencies, the peak-to-peak sensory nerve action potential (SNAP) and maximum sensory conduction velocity (SCV). The bandpass filter setting was 20–3000 Hz. Skin temperature was maintained above 32 °C.

The Mann-Whitney *U* test was used for statistical analysis using the software program Exel-Toukei 2015 (Social Survey Research Information Co., Ltd., Tokyo, Japan).

### 4. Results

In the control subjects, the mean onset latency was  $1.9 \pm 0.14$  ms, mean SNAP was  $23.8 \pm 8.2$   $\mu$ V, and mean SCV was  $64.3 \pm 4.7$  m/s. The SNAP of the affected side in patients 1 and 2 were 7.3  $\mu$ V and 6  $\mu$ V, respectively. The mean SNAP in the two patients was significantly lower than that of the control subjects ( $6.75 \pm 0.92$  vs.  $23.8 \pm 8.2$   $\mu$ V,  $P < 0.05$ ). The side-to-side differences in the SNAP in patients were significantly higher than in the control subjects ( $55 \pm 7.1$  vs.  $11 \pm 7.8\%$ ,  $P < 0.05$ ). The onset latency and SCV did not significantly differ between patients and control subjects.

### 5. Discussion

Cappellari et al. reported a method of NCS for the medial branch of the SRN in healthy subjects [4]. In the present study, we have confirmed that the SNAPs were significantly lower in two patients with suspected injury to the medial branch of the SRN. Furthermore, the side-to-side SNAP difference in the present patients was significantly higher than in the control subjects. These findings indicate that patients clinically suspected of having an SRN injury could have the diagnosis confirmed by electrophysiological examination. We believe that NCS for the medial branch of the SRN may be useful to diagnose distal SRN neuropathy.

Anatomic connections between the SRN and the lateral antebrachial cutaneous nerve (LACBN) have been reported at percentages ranging

from 21%<sup>2</sup> to 75% [6]. Ideally, it is preferable to perform not only the NCS for the SRN, but also for the LACBN. A limitation of the present study was that we did not perform NCS of the LACBN. However, previous cadaver studies have reported that the only overlapping branch between the LACBN and the SRN was the lateral branch [2,3]. Therefore, we believe that it is reasonable to not consider overlapping between the medial branch of the SRN and the LACBN.

The possible volume conduction is another limitation of the present study. Due to anatomical proximity, the SNAP of the medial branch of the SRN might be contaminated by volume conduction from the SNAP of the lateral branch of the SRN. However, we tried to minimize its effect by stimulating the skin just over the medial branch of the SRN and by placing the reference electrode within 2 cm distance from the recording electrode.

The small patient sample size is another limitation of the present study. A small sample size could emphasize a sample bias. A larger patient group is needed to confirm our results.

### 6. Conclusions

This preliminary report indicates that NCS of the medial branch of the SRN may be helpful in confirming the diagnosis of distal SRN injury. Further studies are needed to confirm the diagnostic utility in a larger number of patients with distal SRN injury.

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### References

- [1] D.M. Auerbach, E.D. Collins, K.L. Kunkle, et al., The radial sensory nerve. An anatomic study, *Clin. Orthop. Relat. Res.* 308 (1994) 241–249.
- [2] Z.A. Ikiz, H. Ucerler, Anatomic characteristics and clinical importance of the superficial branch of the radial nerve, *Surg. Radiol. Anat.* 26 (2004) 453–458.
- [3] B.K. Park, H.R. Bun, M. Hwang, et al., Medial and lateral branches of the superficial radial nerve: cadaver and nerve conduction studies, *Clin. Neurophysiol.* 121 (2010) 228–232.
- [4] A.M. Cappellari, A.R. Bona, K. Lukasova, Electrophysiological study of medial and lateral branches of the superficial radial nerve, *Muscle Nerve* 47 (2013) 105–107.
- [5] N.S. Cho, K.H. Kim, B.K. Park, et al., Superficial radial sensory neuropathy: medial and lateral branch injury, *Muscle Nerve* 53 (2016) 690–693.
- [6] S.E. Mackinnon, A.L. Dellon, The overlap pattern of the lateral antebrachial cutaneous nerve and the superficial branch of the radial nerve, *J. Hand. Surg.* 10 (1985) 522–526.